PNEUMATIC SUSPENSION SYSTEM

DESCRIPTION

The invention relates to a pneumatic suspension system comprising at least the following pneumatic suspension system components:

- A pneumatic suspension bellows made of elastomer material, which has a contouring and an air chamber with a variable volume;

- a pneumatic suspension cover comprising a first fastening zone in which the one end of the pneumatic suspension bellows is secured by means of a clamping ring;

- a pneumatic suspension piston comprising a second fastening zone in which the other end of the pneumatic suspension bellows is secured by means of a clamping ring as well; as well as a roll-off piston on whose outer wall the pneumatic suspension bellows can roll off with formation of a rolling fold;

- an outer guide for the pneumatic suspension bellows; as well as

- a static zone of the pneumatic suspension bellows extending from the first fastening zone up to the outer guide, in most cases in conjunction with an expansion of the outside diameter of the pneumatic suspension bellows.

A pneumatic suspension system of said type is described in laid-open patent specification DE 197 19 505 A1 (FIG. 1). In said system, the pneumatic suspension bellows deviates from the usual cylindrical shape. Changes in the diameter occur within the framework of the overall arrangement of the pneumatic suspension bellows, namely in conjunction with the formation of cylindrical, conical and curved zones of the contour (contoured pneumatic suspension bellows).

Furthermore, the pneumatic suspension bellows is provided with an embedded strength carrier in most cases, whereby the strength carrier can be present in the form of a crossed arrangement, for example with the use of two layers of cord fabric that cross each other (DE 41 36 460 A1; FIGS. 2 and 3). Such a pneumatic suspension bellows is referred to also as a crossed-layer bellows. According to another variation, the strength carrier can be present in the form of axially extending thread reinforcements (DE 36 43 073 A1;

FIG. 1). Such a pneumatic suspension bellows is referred to also as an axial bellows.

In pneumatic suspension systems with an outer guide for the pneumatic suspension bellows, whereby particularly axial bellows are employed, undesirable folds and bends may occur under certain circumstances when such a bellows is operating without pressure. Such folds and bends can reduce the useful life.

Now, for the purpose of avoiding the aforementioned problems, the novel pneumatic suspension system, according to the characterizing part of claim 1, is characterized in that the contoured pneumatic suspension bellows comprises a dynamic zone that is subjected within the area of the rolling fold to a change in the diameter of the pneumatic suspension bellows in relation to the outside diameter of the roll-off piston as it is being subjected to load and relieved. When loaded, a reduction in the diameter occurs, and the diameter of the pneumatic suspension bellows is expanded when it is relieved.

Advantageous design variations are specified in the dependent claims 2 to 13. Said variations are now described in the following.

In the unfolded position in the pressureless condition, the dynamical zone of the pneumatic suspension bellows extends at least partially in a conical form. The following two variations are advantageous in this connection:

Variation I

The dynamical zone of the pneumatic suspension bellows extends substantially exclusively conical.

Especially with the present variation, the static zone of the pneumatic suspension bellows changes into the dynamical zone of the pneumatic suspension bellows without a cylindrical intermediate zone.

Variation II

The dynamical zone of the pneumatic suspension bellows has a first conical section that then changes into a cylindrical center section and from there finally again into a second conical section that ends on the second fastening zone. The first conical section has in this connection a greater expanse than the cylindrical center section. The cylindrical center section in turn has a greater expanse than the second conical section.

Especially with this variation, the static zone of the pneumatic suspension bellows changes into a cylindrical intermediate zone, which is static as well, whereby said

intermediate zone is adjoined by the dynamical zone of the pneumatic suspension bellows.

Irrespective of said two variations, the static zone of the pneumatic suspension bellows extends between the first fastening zone and the outer guide, in particular in a substantially exclusively conical form.

Furthermore, irrespective of which one of said two variations is involved, the outer guide encloses in the relieved position substantially the entire dynamical zone of the pneumatic suspension bellows.

The two variations I and II are now described in greater detail as advantageous exemplified embodiments with the help of schematic drawings, in which:

FIG. 1a shows the pneumatic suspension system of the variation I in the unfolded position in the pressureless condition.

FIG. 1b shows the pneumatic suspension system of the variation I in the partly loaded position in the pressureless condition.

FIG. 2a shows the pneumatic suspension system of the variation II in the unfolded position in the pressureless condition; and

FIG. 2b shows the pneumatic suspension system of the variation II in the partly loaded position in the pressureless condition.

The following list of reference symbols is applicable in connection with said figures:

1, 1'	Pneumatic suspension system
2, 2'	Contoured pneumatic suspension bellow
3, 3'	Pneumatic suspension cover
4, 4'	First fastening zone
5, 5'	Clamping ring
6, 6'	Pneumatic suspension piston
7, 7'	Second fastening zone
8, 8'	Clamping ring
9, 9'	Roll-off piston
10, 10'	Air chamber with variable volume
11, 11'	Outer guide
12, 12'	Contact area of the bellows with the outer guide
13, 13'	Roll-off fold of the pneumatic suspension bellows
A	Static zone of the pneumatic suspension bellows
A1	"
A2	"

B	Dynamic zone of the pneumatic suspension bellows
B1	"
B2	"
B3	"
D	Outside diameter of the pneumatic suspension bellows
D1	Outside diameter of the first fastening zone
D2	Outside diameter of the second fastening zone
D3	Outside diameter of the roll-off piston
D4	Diameter of the pneumatic suspension bellows within the area of the rolling fold.

The pneumatic suspension cover 3 of the pneumatic suspension system 1 according to FIG. 1a comprises a first fastening zone 4 with an outside diameter D1, in which the one end of the pneumatic suspension bellows 2 is secured by means of a clamping ring 5. The pneumatic suspension piston 6, which is disposed opposite the pneumatic suspension cover, consists of a second fastening zone 7 with an outside diameter D2, in which the other end of the pneumatic suspension bellows 2 is secured by a clamping ring 8 as well; as well as of a roll-off piston 9 with an outside diameter D3. The pneumatic suspension bellows encloses in this connection an air chamber 10 with a variable volume. In particular the following parameters apply with respect to the outside diameters D1 and D2 of the two fastening zones:

$D1 > D2$.

The pneumatic suspension bellows 2 with a variable outside diameter D has a static zone A and a dynamic zone B, each of said two zones extending with a conical contour. In the contact zone 12 of the outer guide 11, where the pneumatic suspension bellows 2 has its largest outside diameter D, the static zone A changes into the dynamic zone B without a cylindrical intermediate zone. Within the dynamic zone B, the following parameters preferably apply to the outside diameter D of the pneumatic suspension bellow based on the outside diameter D3 of the roll-off piston 9:

D (maximum) = 1.2 times D3 (in particular 1.15 times D3)

D (minimum) = D3 (in particular 1.05 times D3).

The outer guide 11, which is secured on a component permanently fixed on the auto body, and/or on the pneumatic suspension bellows, substantially encloses the major part of the dynamic zone B of the pneumatic suspension bellows 2.

In the state of the unfolded position in the pressureless condition according to FIG. 1a, the dynamic zone B of the pneumatic suspension bellows 2 is still free of the rolling fold.

In the pneumatic suspension system 1 according to FIG. 1b, a rolling fold 13 develops within the framework of the relief within the dynamic zone with a change occurring in

the contour of the pneumatic suspension bellows. Said rolling fold can roll off on the outer wall of the roll-off piston 9. However, as compared to the condition according to FIG. 1a, no substantial change in the contour of the pneumatic suspension bellows occurs within the static zone A.

Now, the pneumatic suspension bellows 2' of the pneumatic suspension system 1' according to FIG. 2a is characterized by a further advantageous contouring. In the present system, the entire static zone A consists of the two part zones A1 and A2, whereby the conical part zone A1 changes into a cylindrical shape in the contact area 12' of the outer guide 11'. In the present case, the dynamic zone B has a first conical section B1, which is tapering in the direction of the pneumatic suspension piston 6', starting from the outer guide 11', then changing into a cylindrical center section B2, and finally changing again into a second conical section B3, which ends in a tapering form on the second fastening zone 7'. Here, the first conical section B1 has a greater expanse than the cylindrical center section B2. The cylindrical center section B2 in turn has a greater expanse than the second conical section B3.

In the condition of the unfolded position in the pressureless state according to FIG. 2a, the dynamic zone B

of the pneumatic suspension bellows 2' is still free of the rolling fold in the present case as well.

In the pneumatic suspension system 1' according to FIG. 2b, a rolling fold 13' develops within the framework of compression under load within the dynamic zone, attended by a change in the contour of the pneumatic suspension bellows. Said rolling fold is capable of rolling off on the outer wall of the roll-off piston 9'. In the present case, too, no substantial change takes place in the contour of the pneumatic suspension bellow within the static zone A as compared to the condition according to FIG. 2a.

The pneumatic suspension system according to FIG. 1b and, respectively, FIG. 2b is subjected in the course of loading and relieving to a change of the diameter D4 within the zone of the rolling fold 13 and 13', respectively, namely with respect to the outside diameter D3 of the roll-off piston 9 and 9', respectively. When loaded, a reduction of the diameter D4 occurs, and when relieved, the diameter D4 of the pneumatic suspension bellows is increased.